APPLICATION OF LANDSAT-2 TO THE MANAGEMENT OF DELAWARE'S MARINE AND WETLAND RESOURCES

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A. PROBLEMS

Acquisition of imagery and other types of data for assessment of outer continental shelf development impact on coastal zone is slower than expected. Therefore, this task is several months behind schedule.

B. ACCOMPLISHMENTS

1. Ocean Waste Dispersion Study

Thirty-eight nautical miles southeast of Cape Henlopen, Delaware, is located the disposal site for waste discharged from a plant processing titanium dioxide. The discharge is a greenish-brown liquid containing 17 to 23% acid (expressed as H_2SO_4) and 4 to 10% ferrous sulfate. The barge which transports this waste is capable of releasing one million gallons of the liquid upon radio-command from a towing tug. It makes at least four trips to the disposal site per month.

The frequency of this dumping made it possible for the LANDSAT 1 and 2 satellites to image the waste plume in various stages of degradation, ranging from minutes to days after dump initiation. As shown in Table 1, fourteen images were found which show water discolorations in the general vicinity of the waste dump site. The position of the discoloration, the dump pattern and the time difference between the dump and image gave strong indications that the discolorations are the acid plume.

Seven best dates have been selected for detailed analysis of acid waste plume movement and dispersion. Enlarged enhancements of the acid waste patterns, prepared from the LANDSAT MSS digital tapes, aided considerably in studies of the dispersion of the wates. Digital radiometric print-outs of the waste plumes are presently being correlated with concentrations of suspended matter and other substances sampled

TABLE I

List of LANDSAT Images Containing Acid Waste Disposal Plumes and Satellite Overpass Time in Hours After Dump

Date	I.D. Number	Time After Dump
10 October 1972	1079-15133	9 hrs 38 min
27 October 1972	1096-15081	14 hrs 8 min
25 January 1973	1186-15081	4 hrs 3 min
07 April 1973	1258-15085	4 hrs 3 min
13 May 1973	1294-15083	During Dump
22 October 1973	1456-15055	29 hrs 25 min
23 October 1973	1457-15113	53 hrs 31 min
15 December 1973	1510-15052	5 hrs 45 min
15 March 1974	1600-15031	6 hrs 8 min
20 April 1974	1636-15022	14 hrs 47 min
26 May 1974	1672-15012	21 hrs 6 min
04 November 1974	1834-14561	46 hrs 26 min
10 August 1975	5122-14420	During Dump
28 August 1975	2218-14552	Just After Dump

from boats making transects across the plumes at the time of aircraft or satellite overpass. Spectrometers deployed from helicopters and boats have also been used to determine spectral signatures of waste plumes such as the one imaged by LANDSAT on August 28, 1975, having the new figure-eight dump configuration adopted in 1975.

Specifically, the following steps have been or are being implemented:

1. Relative radiance maps of the selected acid waste plumes have been prepared at enlarged scales in the form of computer printouts.
2. The number of radiance steps was optimized in order to enhance plume gradients yet minimize the number of false alarms near the edges of the plume and in background waters.
3. The total area covered by each plume was calculated, defining the boundary of the plume by the weakest, reliable radiance level.
4. The location of the two-dimensional centroid of each plume with

respect to the initial dump point is being determined (2).

Once a month remotely-tracked current drogues have been released at the acid waste disposal site to monitor currents during dump operations and LANDSAT overpasses. Three to four drogues are usually released at three depths: surface, mid-depth and near-bottom. The surface drogue tracks currents in the upper 0.5 meter of the water column; the mid-depth drogue is set just above the summer thermocline at 15 meters; and the near bottom drogue at depths between 25 and 30 meters.

The results of this study should show how effectively LANDSAT can be employed to monitor the location, dispersion and movement of ocean waste disposal plumes.

2. OCS Development Impact on Coastal Zone

Most of the necessary data and imagery has been procured, although it took longer to do it than expected. A detailed plan for the task has been prepared and is shown in Figure 1. The schedule on the bottom of Figure 1, which is being closely adhered to, indicates that an extension on this contract will be required if the task is to be completed to the level indicated in the work statement.

C. SIGNIFICANT RESULTS

1. The spectral signature of the acid waste disposal plume investigated 38 miles off the Delaware coast, is caused primarily by scattering from particulates in the form of suspended ferric iron floc. In comparison the absorption caused by the dissolved fraction of iron and other substances has a negligible effect on the spectral signature.

2. Ocean waste disposal plumes have been observed by LANDSAT 1 and 2 during dump up to 54 hours after dump during fourteen different

passes over the Delaware test site. The spatial resolution, radiometric sensitivity and spectral band location of the LANDSAT multispectral scanner are sufficient to identify the location of ocean waste disposal plumes.

3. The movement and dispersion of ocean waste disposal plumes can be estimated if the original dump location, time and injection method are known. To observe the movement and dispersion of pollutants directly, a more frequent coverage, better radiometric sensitivity and finer spatial resolution are required. Operating LANDSAT in the high gain mode helps to determine plume dispersion more accurately.

4. The results obtained are used by the regional EPA office, state agencies and the DuPont Company to better understand the behavior and fate of wastes dumped in the ocean.

D. PUBLICATIONS

1. Klemas, V., Invited presentation to Captain Jacques Cousteau and Dr. Philippe Cousteau on Ocean Current Measurement with Integrated Drogue-Aircraft-Satellite Systems, NASA Headquarters, Washington, D. C., October 6, 1975.

2. Klemas, V, Bartlett, D., Rogers, R., Coastal Zone Classification from Satellite Imagery. Photogrammetric Engineering and Remote Sensing, Journal of the American Society of Photogrammtry, Vol. 41, No. 3, April, 1975.

3. Klemas, V., Otley, M., Wethe, C., Rogers, R., ERTS-1 Studies of Coastal Water Turbidity and Current Circulation, American Geophysical Union 55th Annual Meeting, Washington, D. C., April 8-12, 1974.

4. Klemas, V., Tornatore, G., Whelan, W., A New Current Drogue for Monitoring Shelf Circulation, American Geophysical Union 56th Annual Meeting, Washington, D. C., June 16-20, 1975.

5. Klemas, V. and Bartlett, D., Application of ERTS-1 and Skylab to Coastal Zone Management, NASA Earth Resources Survey Symposium, Houston, June 8-13, 1975.

6. Klemas, V., Davis, G., Wang, H., Whelan, W., Tornatore, G., A Cost-Effective Satellite-Aircraft-Drogue Approach for Studying Estuarine Circulation and Shelf Waste Dispersion Proceedings Ocean 75 Conference, San Diego, 1974.

7. Klemas, V., Davis, G., Wang, H., Whelan, W., Monitoring Estuarine Circulation and Ocean Waste Dispersion Using Integrated Satellite-Aircraft-Drogue Approach, International Conference on Environmental Sensing and Assessment, Las Vegas, September 14-19, 1975.

8. Klemas, V., Remote Sensing of Wetlands Vegetation and Estuarine Water Properties, Proceedings Third International Estuarine Research Conference, Balveston, October 6-9, 1975. (Invited paper).

9. Seven reports on significant result to NTIS.

E. RECOMMENDATIONS

Make more attempts to obtain LANDSAT MSS imagery of our test site in the high-gain mode to enhance water features (suspended sediment patterns, ocean waste disposal plumes, etc.). NASA had arranged for both LANDSAT 1 and 2 to be operated in the high gain mode during an experiment to determine maximum penetration depths of bands 4 and 5 in the Bahamas between August 26 and September 8, 1975.

F. FUNDS

On schedule.

G. DATA USE

All ordered LANDSAT-2 tapes have been received so far. They have been evaluated and are currently being analyzed. LANDSAT-2 photographic products are used within their range of utility.

H. AIRCRAFT DATA

Aircraft overflights have been on time and/or target. Some imagery has been received and more imagery is on order. Most of the aircraft data will be evaluated during the next four months.

I. PERSONNEL CHANGES

None.

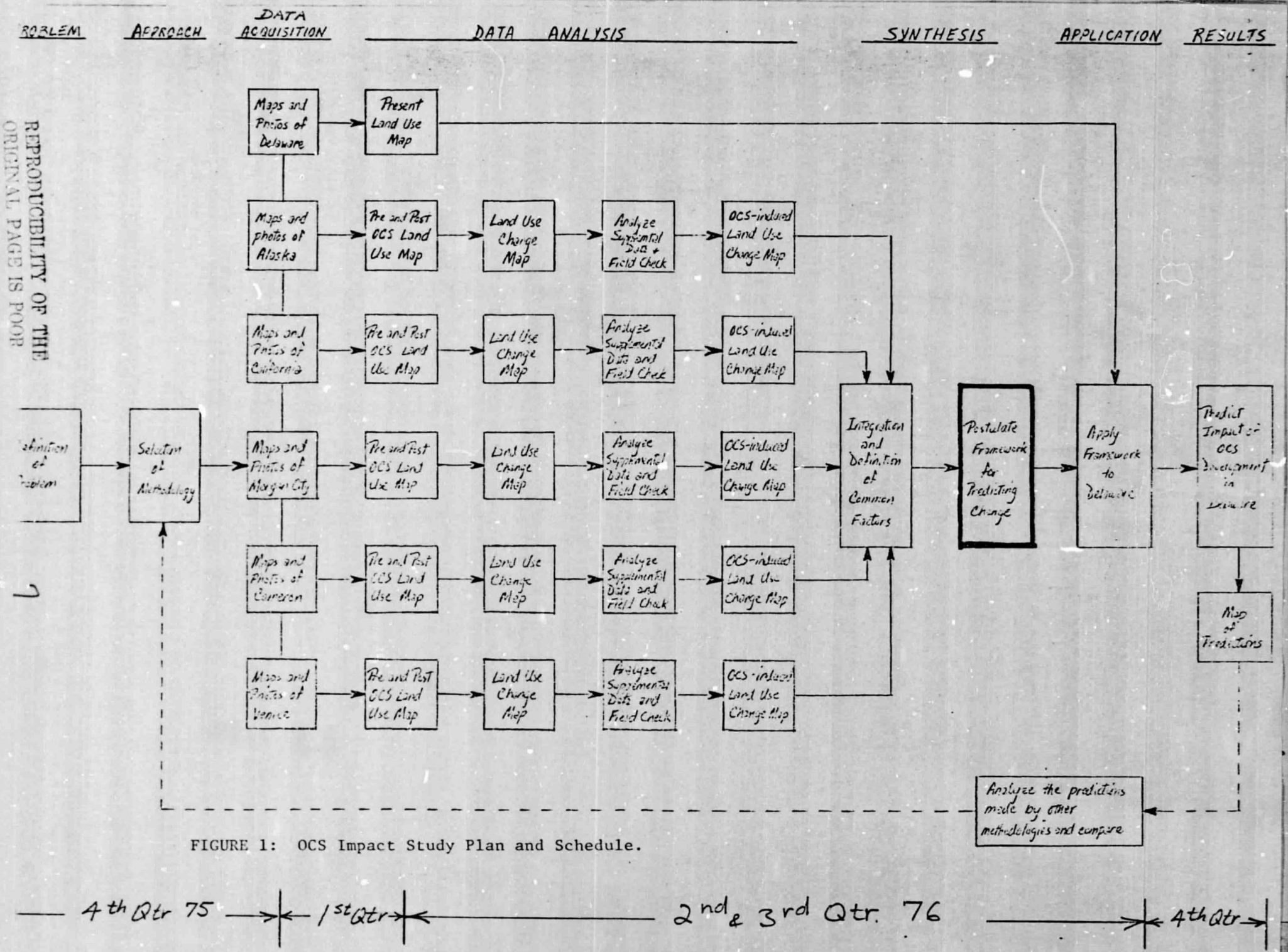

FIGURE 1: OCS Impact Study Plan and Schedule.